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December 2006

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### Recommended Citation

Przybiski, Michael, "Requirements Elicitation in International Research Projects" (2006). *AMCIS 2006 Proceedings*. 535.  
<http://aisel.aisnet.org/amcis2006/535>

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# Requirements Elicitation in International Research Projects

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## ABSTRACT

The elicitation of end-user requirements is primarily focusing on the industry, where companies endeavor to discover and satisfy their customer's requirements. Increasingly however, companies which are working in the same or in different fields are getting together, in order to do joint research and development, despite the fact that they may be potential competitors. These kinds of projects have varying motivations, are often supported by governmental incentives, and participated by academic partners and other for-profit, as well as non-profit organizations. These projects also have to deal with the elicitation of end-user requirements. Current processes however, are not able to take the special characteristics, presented by such project consortia, into account. In this paper we are evaluating the suitability of the wide-audience requirements engineering method, with its new and unique characteristics, for the requirements elicitation process in such international research projects.

## Keywords

Requirements Elicitation, Wide-Audience Requirements Engineering, WARE Method, International Cooperation, Research Projects

## INTRODUCTION

Especially in information and communication technology (ICT) research, but also in other fields, it has in recent years become increasingly common for researchers to work in international research projects. These kinds of projects often involve many different types of partners, even competitors, in a global and culturally very diverse environment. The projects are often funded in part by governmental and non-profit organizations, and in part by private companies and other institutions. The participating organizations form international project consortia, bringing together researchers from different countries, with varying backgrounds and with different interests and expertise.

### International Research Projects

While national research and development projects are often an attempt to promote local research, while bringing academia and industry closer together, international research projects are often motivated by the development of a common (technical) standard, or by promoting special, frequently new technologies or techniques. Often their wide-spread, even global introduction is most beneficial or even required for their success. Examples are typical standardization efforts, such as the GSM standard, or the research and development efforts of the World Wide Web Consortium (W3C<sup>1</sup>). In other cases the project goals are more politically oriented and include for instance the involvement of partners from specific countries, which are to be brought closer to ongoing global research and development.

Whereas challenges in the globalization of information systems have been covered in previous research (e.g., Ives, B. and Jarvenpaa, S. L. (1991), or Tractinsky, N. and Jarvenpaa, S. L. (1995)), this paper focuses on the requirements engineering stage of international research projects. Although such projects have a specific set of goals, already the initial requirements are often not well understood. Current methods of requirement elicitation (RE) are geared towards the industry, which is trying to discover and satisfy the customer's needs. The methods are thus typically not very well suited for these kinds of research projects.

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<sup>1</sup> <http://www.w3.org/>

While the potential end-users can often be found within the project consortium itself, for example developers and researchers, their very special characteristics and constraints need to be taken into account as well. This concerns not only the varying cultural background and the physical distribution. Since the end-user is intimately involved with the project, it also involves the differing approaches towards research methodology and development work itself.

Many factors have to be considered, such as the background of the individual researcher or research groups, as well as the type and the goals of the organizations that take part in the project. Researchers that take part in such a project have often different backgrounds, different fields of expertise and different goals. For them the project often presents a mean to validate their particular research ideas. These different objectives can make the coordination of such project a major challenge, as conflicts have to be avoided. At the same time, the differing goals result in very different, potentially conflicting requirements for the whole project.

### **Requirements Engineering Techniques**

The unique structure of these international research projects makes the process of finding requirements very difficult. Normal requirement elicitation techniques, such as group elicitation, prototyping, contextual or cognitive techniques, as classified by Nuseibeh, B. and Easterbrook, S. (2000) are difficult to apply, due to the varying goals of the participating parties, as well as their physical distribution over different countries.

Traditional techniques, such as questionnaires, surveys, etc. are not suitable due to their direct and immediate involvement of the end-user, which is limited by the international character of the projects discussed here. The prototyping technique as described by Davis, G. B. (1982) with its iterated approach is certainly more suitable in international projects, does however not fit with their research character, as the outcome cannot be prototyped easily. Group elicitation techniques, like brain storming or group support systems (GSS), such as TeamSpirit (Liou, YiChing, Chen, Minder, Fan, Y.W. and Jeffery Chi, Y.P. (2003)) would also be very suitable for the elicitation of end-user requirements, but lack the integration with existing software engineering processes (Herlea, D. E. (1998)). These techniques are furthermore not able to compensate for the lack of knowledge the end user may have, with regard to specific technologies or other contextual information. These are however addressed by contextual techniques (Goguen, J. and Linde, C. (1993)), such as ethno-methodology or conversation analysis. Even though, also those techniques are less suitable for the widely distributed end-users in an international research project. For very special fields, the use of cognitive techniques (Browne, G. J. and Ramesh, V. (2002)), such as protocol analysis can be useful, but it needs to be adapted for more general application.

## **REQUIREMENTS ELICITATION IN INTERNATIONAL RESEARCH PROJECTS**

Requirements elicitation techniques, such as wide-audience requirements engineering (WARE) (Tuunanen, T., Peffers, K. and Gengler, C. E. (2004)), which explicitly take the reach of the user into account, can help the RE process in international research projects significantly. Based on a laddering approach, it can be considered a model-driven technique, even though it does not necessarily rely on a very specific model of the type of information that is gathered. The WARE method also addresses other characteristics of international research projects, such as the differing context of the project participants and the flexible modeling of their goals, or the involvement of decision makers and their need for information.

### **Identification of end-users**

In order to gather requirements it is necessary to identify the potential end-user, the targeted beneficiary of the effort. As mentioned earlier, international research projects can have a wide variety of goals which often already determine what kind of end-users are targeted. Occasionally it is the case that end-users are explicitly defined and at times not directly related to the project itself. While also in these cases the WARE method can be applied, they are not in the focus of this paper. Instead we are here concentrating on cases where the end-user, the beneficiary, is directly participating the project. Especially in the field of information and communication technology (ICT) one common goal is often the development and implementation of a common standard, in order to ensure later interoperability. In these kinds of cases the beneficiary – the end-user – is a group of companies, not primarily a group of individual persons, even though eventually those will benefit from the interoperability of, for instance, consumer products.

It needs to be taken into account that these companies are typically more in the role of competitors, but are in such a project driven by the common goal of profitability. Usually also involved are other types of groups, with varying goals and priorities. The different organizations that take part in these kinds of international projects can be divided at least into the following categories:

- **Governmental funding organizations**, such as the European Commission<sup>2</sup>, which often provide partial funding for projects, while they are participating only on an advisory and management level, and ensure the proper use of funding. Their goal is typically more politically oriented, such as the general promotion of a particular industrial field, the promotion of international cooperation, or the integration of new member-countries.
- **Other non-profit organizations**, especially research organizations, which have a specific field of own research and expertise. These are usually heavily involved in the actual research and mostly interested in the successful dissemination of research results in the academic or industrial field. They are ideally not bound by concerns related to funding or profit, even though they may also benefit from it. This results in the possibility of doing long-term and more theoretical research.
- **Industrial research centers**, which are usually affiliated with a company, have typically a very high level of expertise and a lot of practical experience. While the final goal is for the company to make profit, the researchers and managers often have different levels of freedom of decision making and are able to direct efforts toward long term research. At the same time the practical experience and the close affiliation with the company itself enables the use of latest technologies and products, while bringing research results into early use.
- **Companies and for-profit organizations** are usually motivated to mature the research results as soon as possible and bring them to market, in order to ensure a competitive advantage of the company. These organizations share the goal of profitability, which forces them to focus on short-term and more practical research. Besides this goal of profitability, the organizations are often competitors in the same field and are driven by their own, internal goals, which often are not communicated to other members of the consortium.

These factors result in unique problems in such projects, already in the requirements elicitation process. While for instance a company may be interested in very concrete requirements that can be used in a product in the near future, a research organization may be interested in a more general approach and thus an entirely different set of requirements, whose benefits may become apparent only over a longer period of time.

Other factors, such as cultural differences, also need to be taken into account, especially in the project management. Excluding possible localization requirements, they do however play a lesser role in the requirements elicitation process itself.

In this document we will focus on the different project participants themselves as the beneficiaries and thus as the considered end-users. Especially the researchers in these projects need to be motivated to actively and most of all creatively contribute to the project, which requires taking into account their perhaps individual fields of interest and expertise. The end-users discussed here cannot be considered to belong either to the group of external users or organizational users, as described by Kotonya, G. and Sommerville, I. (1998).

### Applicability of the WARE method

In the past, ICT research projects have dealt with the problem of gathering requirements in different ways. In some cases it was possible to use conventional methods, such as described by Davis, A. M. (1993), to internally gather and present the elicited requirements. In most cases however the RE process has been less structured, as normal processes could not be applied, or required major adaptation efforts.

The WARE method of Tuunanen, T., Peffers, K. and Gengler, C. E. (2004) takes several of the key problems, such as the distribution of the end-users, into account and considers specific RE problems in wide-audience information systems (WAIS):

- **Context**, dealing with the relationship between the end-user and the firm, and the lack of context information available to the end-user. The significance of this problem depends on the research project itself. While sometimes the participants share a common field of expertise, there are often cases in which explicitly partners from different fields are involved.
- **Reach**: the problem of having the end-user available for further clarification of gathered requirements and the collection of further requirements for another product version. In international projects this problem can perhaps be considered less severe, as the participants are usually well known, and reachable by means of modern telecommunication. Project meetings also ensure the communication between partners, the exchange of further

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<sup>2</sup> <http://www.cordis.lu/>

information and the clarification of difficult issues. However, in practice there are limits to the ability of finding solutions by remote communication and, especially in the RE phase, a more efficient mechanism would be very beneficial.

- The **Modeling** and **Model Aggregation** issues deal with the lack of common knowledge between the actual product developer and the eventual end-user, as well as between different end-users. Similar to the problem of common context, mentioned above, this is often dependent on the project itself and the composition of the project consortium. Having the project participants themselves as potential end-users can reduce this problem. However, in case the project partners are from sufficiently different backgrounds, this problem can become very serious, as different experts have different backgrounds, knowledge and experience, which can easily lead to unnecessary misunderstandings and controversy. Sometimes this problem can be resolved by partners providing a basic level of education within the consortium.
- **Presentation** and **Consensus making** refer to the problem of differing perspectives and understanding between management and end-users or management and developers respectively. Also in the case of international research projects this problem is very frequent. The end-users, being members of the project, have typically different interests from those of the decision makers, who are constrained by the goals of the affiliated organization, as described earlier. Researchers are typically motivated by being able to do research in their own field of expertise, whereas management is typically driven by other goals. In some cases this problem can be decreased, or altered by having a researcher responsible for management tasks. If this is not the case, often also the understanding between decision makers and developers differs significantly, causing further problems.
- Eventually, WARE also deals with the problem of the **Requirements-design interface**, the methodology to model the results of the RE process in such a way as to be understandable by the end-user. This problem is perhaps less applicable in the case of research projects, where the end-user and the developer are essentially in the same group.

The WARE method addresses these problems directly. However, in international research projects another problem can be identified:

- **Organizational restrictions and goals** often play an integral part of the RE process of the individual organization. Even though this could be attributed to the Model Aggregation problem above, it is in fact a separate obstacle, as it refers not to the lack of common knowledge, but instead to un-communicated constraints of the individual organization. These can be related for instance to the long-term goals of the organization, or to established internal conventions.

This problem can however only be generally taken into account during the RE process, as it is more related to project management, whose problems with globalization have already been studied previously (e.g., Ives, B. and Jarvenpaa, S. L. (1991)).

## EVALUATION

The WARE method applies altogether very well to the problems, faced in the requirements elicitation process of international research projects, especially in the field of ICT. At the same time, the size of these kinds of projects is sufficient to gather all requirements and also provides “lead users”, which are quickly adopting new technologies (Rogers, E. M. (1995)). Within a limited amount of time it is possible to conduct the necessary interviews and gather the requirements, using the laddering method (Peffer, K., Gengler, C. E. and Tuunanen, T. (2003)), which WARE is based upon.

A follow-up analysis can then be carried out separately, and without the needed presence of all end-users, resulting in a well-defined set of functional, as well as non-functional requirements. If necessary it is still possible to consult with experts inside the consortium, in order to refine the results further.

In the case of an iterative development approach in the project, a very early evaluation of the use of the WARE method for the requirements elicitation process may be possible. The process provides the priorities for the different requirements, which can be implemented iteratively. As part of each iterative cycle, the fulfillment of requirements can be already be evaluated. It is possible to correct or refine requirements and select those requirements that should be implemented as part of the next development iteration. In case another development approach is taken, an evaluation can be done similar to the method described by Peffer, K. and Tuunanen, T. (2005).

## CONCLUSION AND FURTHER RESEARCH

In this paper we presented the requirements elicitation process of international research projects, specifically in the field of information and communication technology (ICT). We studied the suitability of the wide-audience requirements engineering (WARE) method for eliciting end-user requirements in these kinds of projects. We analyzed how the problems, identified for the WARE method relate to the special restrictions in these types of projects and how the method itself can be applied in such an environment.

We intend to apply the WARE method in proposed and in currently starting projects, in order to evaluate its practical usability in such international research of projects. We believe that its application will significantly benefit the project and result in a set of well defined and clearly understood requirements, as well as their motivation.

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